i'Tec_B3
September 2007

Keywords: Grinding, grain size, protein, pea

Pea grinding process

Influence of differing diagrams on pea protein distribution in a series of grain size fractions

1. Focus

The purpose of this study was to establish how the grinding diagram (pregrinding/predosing/dual-mode) affects pea protein content in a series of grain size fractions.

2. Equipment and methods

All the products were ground using a laboratory blade grinder. The machine had a linear blade speed of 59.4 m/s.
A batch of Baccara peas marked N15 was used as a raw material and nitrogen tracer.
Table 1 shows the composition of the ground formula in the premix or dual-mode diagram.

N15 peas	Wheat	Corn	Soyabean cake
20.0	43.2	14.4	22.4

Table 1: Formula composition (%)

The following grinding methods were used:

- Dual-mode diagram – M1 flour - 3-mm screen: The peas were processed as a pregrinding and then added to three raw materials, after which they were ground as a premix (Figure 1).
- Predosing diagram – PM 2 flour - 3-mm screens – The peas were ground as a predosing along with the three other raw materials (Figure 2).
- Pregrinding diagram – PB3 flour - 2.5-mm screens (peas) or 3-mm screens (corn, wheat and soyabean cake) (Figure 3).
- Pregrinding diagram – PB4 flour - 3-mm screens (peas, corn, wheat and soyabean cake) (Figure 4).

Prior to grinding as a premix, the mixes to be used in the M1 and PM2 flours were dosed at 1/10 of a gram, and then premixed by hand.

The measured variables were:

- Dumas nitrogen, N15 and dry matter contents, which were dosed at INRA St. Gilles for 4 grain size fractions (Table 2).
- Flour grain size and separation into grain size fractions; performed by dry sieving using a Bühler laboratory plansifter, tapping the sieving screen at 5-minute intervals to clean it manually. It was decided to use this equipment as its efficacy in separating out the finest grain size fractions had already been demonstrated in a preliminary study.

Grain size fractions (F)
F < 160 µm
160 µm < F< 400 µm
400 µm < F< 1000 µm
1000 µm < F

Table 2: Analysed grain size fractions

3. Results and discussion

3.1. Product grain size

Table 3 and Table 4 illustrate the results, which showed that flour grain size is dependent on screen aperture diameter and the grinding diagram.
Based on the interpolated median diameters:

- the median diameter of peas ground on 3-mm screens is 24% larger than that of a flour ground on a 2.5-mm screen.
- at an identical screen aperture diameter (3mm), the dual-mode diagram produces the smallest grain size (M1 flour - 548 µm), followed by the predosing diagram (PM2 flour – 609 µm), with the pregrinding diagram producing the coarsest-grained flour (PB4 flour – 620 µm).

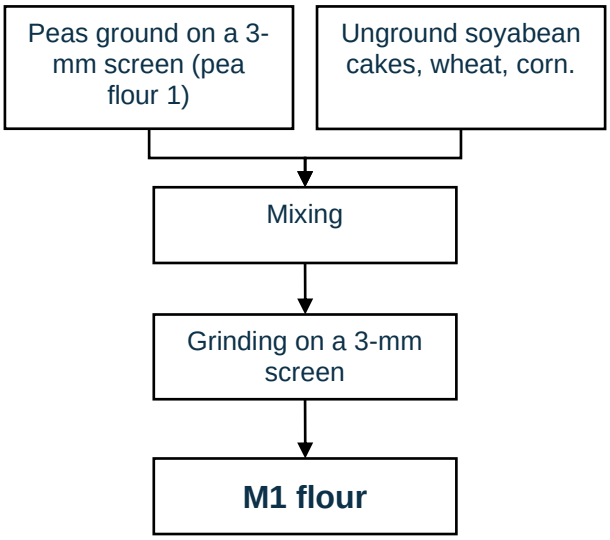

Figure 1: Dual-mode diagram –M1 flour

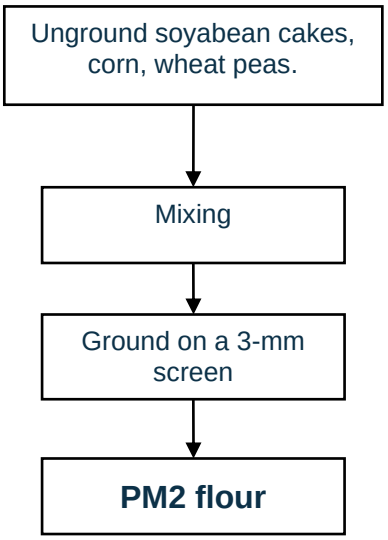

Figure 2: Predosing diagram –PM2 flour

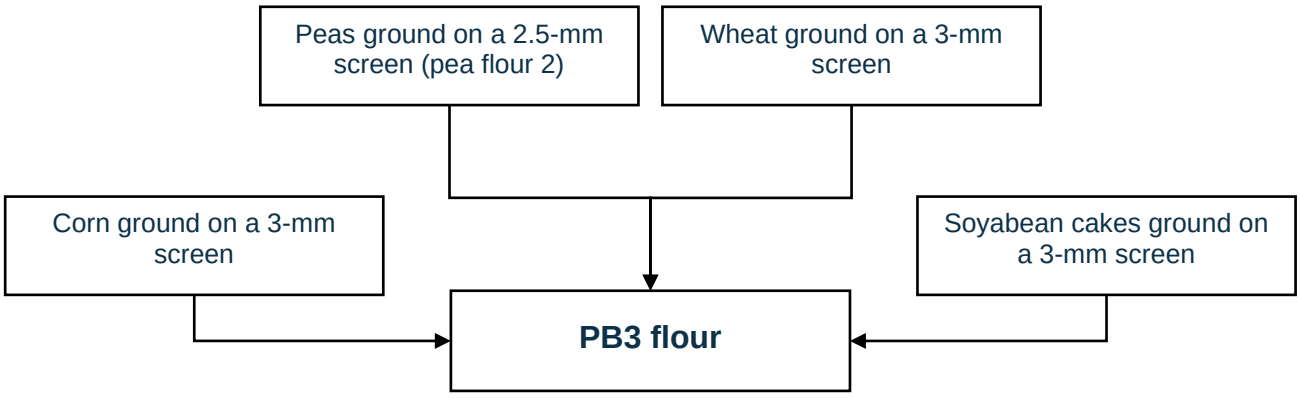

Figure 3: Pregrinding diagram – PB3 flour

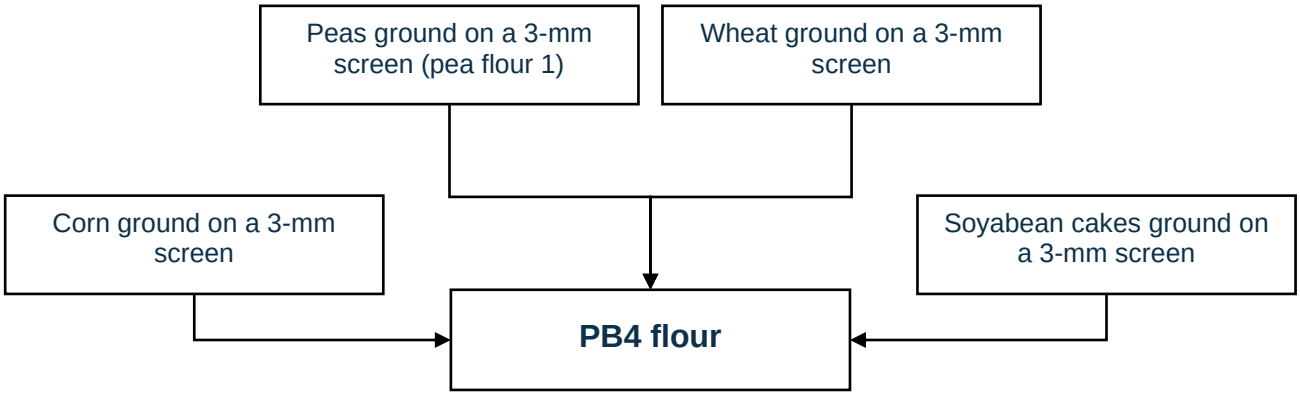

Figure 4: Pregrinding diagram – PB4 flour

Grinding diagram	Pregrinding							Dual-mode	Predosing
Product	Pea flour 1	Pea flour 2	Wheat	Corn	Soyabean cake	PB3 flour	PB4 flour	M1 flour	PM2 flour
Grinder screens	3 mm	2.5 mm	3 mm	3 mm	3 mm	2.5 or 3 mm (a)	3 mm	3 mm	3 mm
d50 Gaussian-log (µm)	757	600	621	442	481	555	581	506	562
d50 Interpolation (µm)	855	690	700	457	487	597	620	548	609

Table 3: Flour grain size – statistical parameters

(a) 2.5-mm screens for peas, 3-mm screens for the other raw materials

Grinding diagram		Pregrinding							Dual-mode	Predosing
Product		Pea flour 1	Pea flour 2	Wheat	Corn	Soyabean cake	PB3 flour	PB4 flour	M1 flour	PM2 flour
Grinder screens		3 mm	2.5 mm	3 mm	3 mm	3 mm	2.5 or 3 mm (a)	3 mm	3 mm	3 mm
Sieve (µm)	80				5.3	5.4	2.0	2.0		
	100		12.6	9.2	5.6	1.8	7.7	5.2	13.8	11.4
	125	9.3	0.7	2.8	6.1	3.1	2.9	4.6	2.1	1.8
	160	1.4	1.4	2.0	4.3	2.5	2.3	2.3	2.1	2.0
	200	2.1	2.5	3.1	5.0	4.8	3.6	3.6	3.5	3.1
	250	3.1	3.6	4.2	6.5	6.9	5.0	4.9	5.2	4.9
	315	4.8	5.8	6.3	9.7	11.7	7.9	7.7	7.8	7.3
	400	4.1	4.8	4.5	6.7	8.8	5.8	5.7	5.9	5.5
	500	6.8	8.6	8.2	10.5	14.5	10.0	9.7	10.8	10.2
	630	9.0	11.6	10.4	10.5	13.5	11.3	10.8	12.3	11.9
	800	12.1	14.4	12.4	9.9	10.9	12.1	11.6	12.4	12.5
	1000	15.8	16.6	14.6	9.6	8.5	12.9	12.8	11.5	12.8
	1250	19.0	13.7	13.9	10.3	7.6	11.9	13.0	8.9	11.0
	1600	10.1	3.8	8.4			4.4	5.6	3.7	5.6
	2000	2.4						0.5		

Table 4: Distributions according to sieve size (% by weight)

(a) 2.5-mm screens for peas, 3-mm screens for the other raw materials

Diagram		Pregrinding		Dual-mode	Predosing
Products		PB3 flour	PB4 flour	M1 Flour	PM2 flour
Grinder screens		2.5 or 3 mm (a)	3 mm	3 mm	3 mm
Grain size fractions (µm	F ≤ 160	11.79	7.94	25.66	12.76
	160 <F ≤ 400	15.03	12.14	19.52	12.95
	400 < F ≤ 1,000	39.63	30.63	33.55	33.13
	1,000 < F	33.55	49.28	21.28	41.16

Table 5: Pea grain size and nitrogen contents (% N from peas)

(a) 2.5-mm screens for peas, 3-mm screens for the other raw materials

3.2. Pea nitrogen content in the various grain size fractions

As seen with the previous criterion, the distribution of pea nitrogen in the various grain size fractions is determined by the grinding diagram and the diameter of grinder screen apertures (Table 5 and Figure 5).

At an identical grinder screen aperture diameter (3 mm), grinding diagrams can be classified in de-

scending order based on the percentage of pea nitrogen identified in the finest-grained fractions (fractions below 160µm and fractions between 160 and 400µm): dual-mode diagram (M1 flour), pregrinding diagram (PB3 flour), predosing diagram (PM2 flour) and pregrinding diagram (PB4 flour).

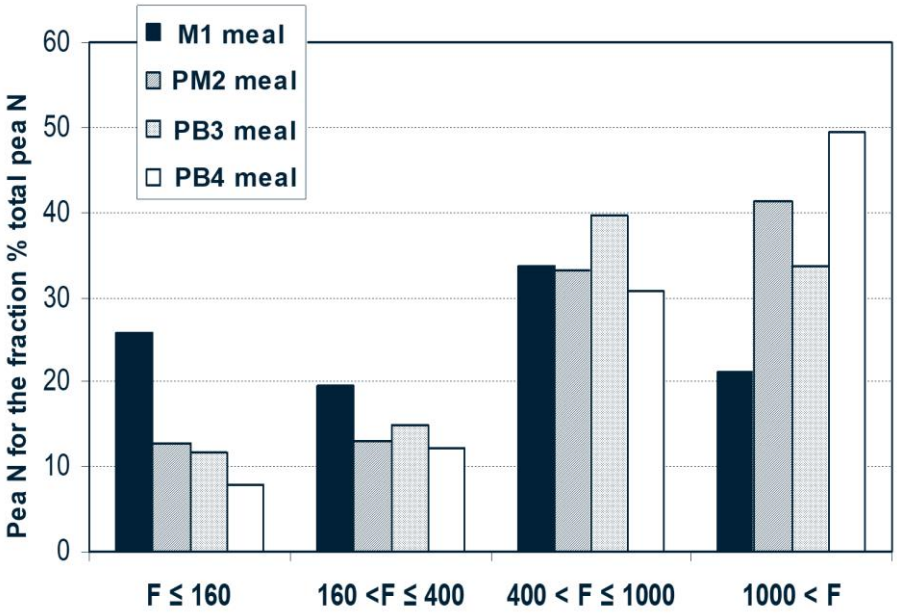

Figure 5: Pea N in each size fraction as a % of total pea N

4. Conclusion

Comparing diagrams produced with an identical grinder screen aperture diameter reveals that:

- the grain size obtained with a pregrinding diagram is coarser than that obtained with a predosing diagram, while the dual-mode diagram gives the smallest grain size.
- pea nitrogen distribution patterns in flours obtained in pregrinding or predosing diagrams were fairly similar. The dual-mode diagram was the only one that modified this pattern, through a significant increase in the percentage of pea nitrogen found in the fractions with the smallest grain size (< 400 µm).

In an industrial context, the results of this study demonstrate that solutions do exist for pea nitrogen enrichment of the finest-grained flours (< 400µm) depending on the chosen plant diagram:

- a plant using the pregrinding system would have to grind the peas on a 2.5-mm screen.
- a plant using the predosing system would have to set up a dual-mode diagram, using 3-mm screens.

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